

Amendment
Serial No. 10/026,378
Page 13

REMARKS

In view of the following discussion, the applicants submit that none of the claims now pending in the application are anticipated under the provisions of 35 U. S. C. § 112, or obvious under the provisions of 35 U. S. C. § 103. Furthermore, all of the claims presently in the application satisfy the requirements of 35 U. S. C. § 112. Thus, the applicants believe that all of these claims are now in allowable form.

Rejections

A. 35 U. S. C. § 112

Claims 1-73 stand rejected under 35 U. S. C. § 112. In particular, the Examiner indicates that the compound TiSiN appears improbable. In response, U. S. Patent 6,017,818 issued to Lu and cited by the Examiner recites TiSiN films in the Abstract and throughout. As such, applicants respectfully request that the Examiner withdraw this rejection.

Claims 13, 38, 49, 60 and 72 are also rejected for reciting nitrogen, argon and helium in a markush group for a hydrogen-containing plasma. These claims have been amended to remove nitrogen, argon and helium from such markush group.

Claim 15 is rejected for reciting two identical steps, (b) and (d). Claim 15 has been amended to distinguish step (d) from step (b).

Claims 26 and 62 are rejected for reciting the formation of the barrier layer in the preamble with no positive recitation thereof in the body of the claim. Claims 26 and 62 have been amended to positively recite the formation of the barrier layer in the body of the claim.

Amendment
Serial No. 10/026,378
Page 14

In view of the above amendments, the basis for the Examiner's rejection of claims 1-73 pursuant to 35 U. S. C. § 112 has been removed. Therefore, it is respectfully requested that this rejection be withdrawn.

B. 35 U. S. C. §102

1. Claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are not anticipated by Shue et al.

Claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are not anticipated by Shue et al (U. S. Patent 6,271,136 issued August 7, 2001). Applicants submit that claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are not anticipated by this reference.

Claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are directed to a method of constructing a titanium silicon nitride film on a substrate. In particular, claim 1 includes the following steps:

"A method of film deposition, comprising:

- forming a titanium nitride (TiN) layer on a substrate in a process chamber;
- removing reaction by-products generated during titanium nitride (TiN) layer formation from the process chamber; and
- exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer."

In claim 1, a titanium nitride film is formed, reaction by-products generated during film formation are removed from the process chamber and then such layer is exposed to a silicon containing gas to form a titanium silicide nitride layer.

Amendment
Serial No. 10/026,378
Page 15

Shue et al. describes a method for forming a Ti-Si-N film. The Ti-Si-N film is formed from the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form a TiN layer, that is plasma treated using a nitrogen/hydrogen plasma followed by a silicon-containing gas.

Shue et al. does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Shue teaches the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form a TiN layer, that is plasma treated using a nitrogen/hydrogen plasma followed by a silicon-containing gas. As such, claims 1-2, 5-6, 10, 13-16, 19-20, 24-27, 30-31, 35, 38-39 are patentable over Shue et al.

C. 35 U. S. C. § 103

1. Claims 1-9, 26-34, 40-45 and 62-67 are not obvious over Lu in view of Sivaram

Claims 1-9, 26-34, 40-45 and 62-67 stand rejected under 35 U. S. C. § 103(a) as being unpatentable over Lu (U. S. Patent 6,017,818 issued January 25, 2000) in view of Sivaram (paper entitled "Chemical Vapor Deposition"). Applicants submit that claims 1-9, 26-34, 40-45 and 62-67 are not rendered obvious by the combination of these references.

Claims 1-9, 26-34, 40-45 and 62-67 are directed to a method of constructing a titanium silicon nitride film on a substrate. In particular, claim 1 includes the following steps:

"A method of film deposition, comprising:
forming a titanium nitride (TiN) layer on a substrate in a
process chamber;

Amendment
Serial No. 10/026,378
Page 16

removing reaction by-products generated during titanium nitride (TiN) layer formation from the process chamber; and
exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer."

In claim 1, a titanium nitride film is formed, reaction by-products generated during film formation are removed from the process chamber and then such layer is exposed to a silicon containing gas to form a titanium silicide nitride layer.

Lu describes a method for forming a Ti-Si-N film (see, Lu at column 2, lines 16-19). The Ti-Si-N film is formed from the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form a TiN layer, that is then annealed using a silicon-containing gas (see, Lu at column 3, line 40 to column 4, line 21).

Lu does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Lu teaches a completely different method utilizing an annealing process. As such, claims 1-9, 26-34, 40-45 and 62-67 are patentable over Lu.

Sivaram generally describes CVD processes and in particular formation of titanium nitride (see Sivaram at page 197-201). Sivaram does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Sivaram only teaches a process for forming TiN. As such, claims 1-9, 26-34, 40-45 and 62-67 are patentable over Sivaram.

Furthermore, since Lu teaches a Ti-Si-N layer formation method utilizing an annealing process and Sivaram only teaches a process for forming TiN, neither reference when combined describes or suggests applicants invention

Amendment
Serial No. 10/026,378
Page 17

wherein a titanium nitride film is formed, reaction by-products generated during film formation are removed from the process chamber and then such layer is exposed to a silicon containing gas to form a titanium silicide nitride layer. Thus, claims 1-9, 26-34, 40-45 and 62-67 are patentable over the combination of these references.

2. Claims 10-25, 35-39 and 41-61 are not obvious over Lu in view of Sivaram and further in view of Kim et al or Sandhu or Ho et al.

Claims 10-25, 35-39 and 41-61 stand rejected under 35 U. S. C. § 103(a) as being unpatentable over Lu (U. S. Patent 6,017,818 issued January 25, 2000) in view of Sivaram (paper entitled "Chemical Vapor Deposition") and further in view of Kim et al. (GB Patent 2299345) or Sandhu (U. S. Patent 5,567,483 issued October 22, 1996). Applicants submit that claims 10-25, 35-39 and 41-61 are not rendered obvious by the combination of these references. Claims 10-25, 35-39 and 41-61 depend from claims 1, 26 and 40 respectively. The Examiner applied Lu and Sivaram as discussed above with respect to claims 1, 26 and 40.

Lu does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Lu teaches a completely different method utilizing an annealing process. As such, claims 10-25, 35-39 and 41-61 are patentable over Lu.

Sivaram does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Sivaram only teaches a process for forming TiN. As such, claims 10-25, 35-39 and 41-61 are patentable over Sivaram.

Amendment
Serial No. 10/026,378
Page 18

Kim et al. describes a method of forming a TiN film from organometallic precursors (see, Kim et al. at page 2, lines 23-24). After formation, the TiN film is plasma treated using a hydrogen/nitrogen atmosphere (see, Kim et al. at page 2, lines 24-27). Such plasma treatment step dissociates oxygen from the TiN film (see, Kim et al. at page 3, lines 24-28).

Kim et al. does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Kim et al. teaches a completely different method wherein a hydrogen/nitrogen atmosphere is used to plasma treat a TiN film formed from an organometallic precursor. Thus, claims 10-25, 35-39 and 41-61 are patentable over Kim et al.

Sandhu describes a method of forming films from organometallic precursors (see, Sandhu at column 1, lines 40-48). After formation, the films are plasma treated using a hydrogen/nitrogen atmosphere (see, Sandhu at column 5, lines 25-35).

Sandhu does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Sandhu teaches a completely different method wherein a hydrogen/nitrogen atmosphere is used to plasma treat a film formed from an organometallic precursor. Thus, claims 10-25, 35-39 and 41-61 are patentable over Sandhu.

Foster et al. describes a method of forming a TiN film from organometallic precursors. After formation, the TiN film is plasma treated using a hydrogen/nitrogen atmosphere.

Foster et al. does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Foster et al. teaches a completely different

Amendment
Serial No. 10/026,378
Page 19

method wherein a hydrogen/nitrogen atmosphere is used to plasma treat a TiN film formed from an organometallic precursor. Thus, claims 10-25, 35-39 and 41-61 are patentable over Foster et al.

Furthermore, since Lu teaches a Ti-Si-N layer formation method utilizing an annealing process, Sivaram only teaches a process for forming TiN, and Kim et al., Sandhu or Foster et al only teach a method wherein a hydrogen/nitrogen atmosphere is used to plasma treat a TiN film, neither reference when combined describes or suggests applicants invention wherein a titanium nitride film is formed, reaction by-products generated during film formation are removed from the process chamber and than such layer is exposed to a silicon containing gas to form a titanium silicide nitride layer. Thus, claims 10-25, 35-39 and 41-61 are patentable over the combination of these references.

3. Claims 3-4, 7-9, 11-12, 17-18, 21-23, 28-29, 32-34 and 36-37 are not obvious over Shue et al. in view of Sivaram

Claims 3-4, 7-9, 11-12, 17-18, 21-23, 28-29, 32-34 and 36-37 stand rejected under 35 U. S. C. § 103(a) as being unpatentable over Shue et al (U. S. Patent 6,271,136 issued August 7, 2001) in view of Sivaram (paper entitled "Chemical Vapor Deposition"). Applicants submit that claims 3-4, 7-9, 11-12, 17-18, 21-23, 28-29, 32-34 and 36-37 are not rendered obvious by the combination of these references.

Shue et al. does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and than exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Shue teaches the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form a TiN layer, that is plasma treated using a nitrogen/hydrogen plasma followed by a silicon-containing gas. As such, claims 3-4, 7-9, 11-12, 17-18, 21-23, 28-29, 32-34 and 36-37 are patentable over Shue et al.

Amendment
Serial No. 10/026,378
Page 20

Sivaram does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Sivaram only teaches a process for forming TiN. As such, claims 3-4, 7-9, 11-12, 17-18, 21-23, 28-29, 32-34 and 36-37 are patentable over Sivaram.

Furthermore, since Shue only teaches the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form a TiN layer, that is plasma treated using a nitrogen/hydrogen plasma followed by a silicon-containing gas and Sivaram only teaches a process for forming TiN, neither reference when combined describes or suggests applicants invention wherein a titanium nitride film is formed, reaction by-products generated during film formation are removed from the process chamber and then such layer is exposed to a silicon containing gas to form a titanium silicide nitride layer. Thus, claims 3-4, 7-9, 11-12, 17-18, 21-23, 28-29, 32-34 and 36-37 are patentable over the combination of these references.

4. Claims 40-74 are not obvious over Shue et al. in view of Lu and Sivaram

Claims 40-74 stand rejected under 35 U. S. C. § 103(a) as being unpatentable over Shue et al (U. S. Patent 6,271,136 issued August 7, 2001) in view of Lu (U. S. Patent 6,017,818 issued January 25, 2000) and Sivaram (paper entitled "Chemical Vapor Deposition"). Applicants submit that claims 40-74 are not rendered obvious by the combination of these references.

Shue et al. does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Shue teaches the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form

Amendment
Serial No. 10/026,378
Page 21

a TiN layer, that is plasma treated using a nitrogen/hydrogen plasma followed by a silicon-containing gas. As such, claims 40-74 are patentable over Shue et al.

Lu does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Lu teaches a completely different method utilizing an annealing process. As such, claims 40-74 are patentable over Lu

Sivaram does not describe or suggest forming a titanium nitride film, removing reaction by-products generated during film formation from the process chamber and then exposing such layer to a silicon containing gas to form a titanium silicide nitride layer. Rather, Sivaram only teaches a process for forming TiN. As such, claims 40-74 are patentable over Sivaram.

Furthermore, since Shue only teaches the thermal decomposition of a metallo-organic titanium precursor and a nitrogen containing precursor to form a TiN layer, that is plasma treated using a nitrogen/hydrogen plasma followed by a silicon-containing gas, Lu teaches a method of TiSiN formation utilizing an annealing process and Sivaram only teaches a process for forming TiN, neither reference when combined describes or suggests applicants invention wherein a titanium nitride film is formed, reaction by-products generated during film formation are removed from the process chamber and then such layer is exposed to a silicon containing gas to form a titanium silicide nitride layer. Thus, claims 40-74 are patentable over the combination of these references.

Conclusion

Thus, applicants submit that none of the claims, presently in the application, are anticipated under the provisions of 35 U. S. C. §102, or obvious under the provisions of 35 U. S. C. § 103. Consequently, the applicants believe that all of the claims are presently in condition for allowance. Accordingly, both

Amendment
Serial No. 10/026,378
Page 22

reconsideration of this application and its swift passage to issue are earnestly solicited.

If, however, the Examiner believes that there are any unresolved issues requiring adverse final action for any of the claims now pending in this application, it is requested that the Examiner telephone Mr. Raymond Moser, at (732) 530-9404, so that appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Respectfully submitted,

7/11/03

Patricia A. Verlangieri
Patricia A. Verlangieri, Attorney
Reg. No. 42,201
(732) 530-9404

Moser, Patterson & Sheridan LLP
Attorneys at Law
595 Shrewsbury Avenue
Suite 100
Shrewsbury, N. J. 07702

Please continue to direct all correspondence to:

Patent Counsel
Applied Materials, Inc.
3050 Bowers Avenue
P. O. Box 450A
Santa Clara, CA 95052

CERTIFICATE OF FACSIMILE TRANSMISSION UNDER 37 C.F.R. § 1.8

I certify that this correspondence is being transmitted by facsimile under 37 C. F. R. § 1.8 on July 11, 2003 and is addressed to the Commissioner for Patents, P. O. Box 1450, Alexandria VA 22313
Facsimile Number: (703) 872-9310

PATRICIA VERLANGIERI
Type or print name of person signing certification

Patricia A. Verlangieri
Signature

FAX RECEIVED
JUL 14 2003
GROUP 1700